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Lifespan of information service firms in Japan: a survival analysis

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Abstract:
The purpose of this paper is an analysis of survival in the Japanese information service industry. Information service firms are generally classified into two typical patterns. One is the group of independent firms such as software vendors, and the other is the group of non-independent such as subsidiaries established by spinning off and so on. We used a sample of 334 firms in Japan and analyzed by Kaplan-Meier estimator method and Cox proportional hazard regression model in order to investigate the difference of survival between these two groups and/or among other attributes. As a result, the lifespan of the information service firms significantly depends on the degree of system integration sales ratio, software development sales ratio, and entrusted processing sales ratio. On the contrary, property of non-independence and high sales ratio with main customers have a negative influence on their survival rates, i.e. lifespan. The paper discusses these results and offers some managerial implications, and future research opportunities are provided.

Keywords:
Survival analysis; Kaplan-Meier estimator; Cox proportional hazard regression model; information service industry.

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1. Introduction

In general, firms in the private sector can be classified into two typical groups. One is the group in which firms are placed under the capital of its major parent company and the other consists of independent firms. It is no exception in the information service and/or software industry. Hence, information service industry has two groups: (1) the group of non-independent such as subsidiaries established by spinning off and so on, and (2) the group of independent firms such as software vendors or software houses [1]-[7]. In Japan, especially in larger companies, it can be said that subsidiaries related to the information service or system (IS subsidiaries) have been established and utilized so far.

Indeed, the Japan Information Processing Development Corporation (2006) made it appear that the rate of companies setting up their own IS subsidiaries is 8.3% as a whole in Japan [8]. However, depending on the size of the company, its own IS subsidiaries tend to be established. That is to say, 25.5% of the companies who have from 1000 to less than 5000 employees are setting up their own IS subsidiaries. In addition, it reaches the rate of 61.8% in the companies having 5000 employees or over. Moreover, this report reveals in detail that large-scale companies tend to establish their own IS subsidiaries by spinning off their in-house information systems department.

However, few studies have empirically analyzed differences in characteristics between the two groups: Ind. group and Non-ind. group mentioned above. Even more, to the best of our knowledge, only a few studies of the determinant factors that have influence on the survival or lifespan of information service firms have been published until today. The main contribution of this paper is to identify the effects of factors influencing firm survival in the Japanese information service industry.

This paper is organized as follows. In Section 2, we mention about the background of this study and briefly review some relevant researches about the survival or life-span of firms. Section 3 describes the data and method of survival analysis. Section 4 presents the results of the log-rank test of survival analysis and Cox proportional hazard regression analysis. Finally in Section 5 we conclude by a summary of this paper.

2. Background and literature review

A previous research concerning the information service and/or software industry in Japan is the empirical study that Baba et al. [9] have conducted. According to this study, the user-driven nature, that is the role played by the large users of software as compared to the roles of independent software houses, is an important factor to structure this industry in Japan. The main conclusion is that the structure of the Japanese software industry has inhibited the development of packaged software and also the evolution of innovative independent software houses. Therefore, with the current trend in the computer industry towards down-sizing and open systems, the structure of the Japanese software industry presents critical weaknesses.

Anchordoguy [10] analyzed the key cause of the current weakness of Japan's software industry, and concluded that it arises from the institutional arrangements of Japan's system of catch-up capitalism. These are said to include industrial policy; the *Keiretsu* industrial groups; a centralized, bank-centered financial system; lack of enforcement of the antimonopoly law; a weak intellectual property regime; and education and employment systems that emphasize conformity, loyalty, and stability. *Keiretsu* means the group of large Japanese financial and industrial relationships through historical associations and cross-shareholdings.

Thus, literature has attributed Japan’s weakness in the global business software sector to the specific institutional settings or social system, however, Storz [11] argues that it is precisely the dynamics within innovation systems which have enabled Japan to charge forward as a global leader in a highly innovative field: the game software sector.

On the other hand, the survival analysis as methodology has been widely used in many studies in the field of management. For example, Demirbag et al. [12] analyzed the factors affecting survival of foreign subsidiaries in the context of Japanese foreign equity ventures in the Middle East and North Africa. Morikawa [13] analyzed the relationship between family ownership of firms and productivity growth and survival by using data on a large number of Japanese firms. The conclusion is that their probability of survival over a six-year period is 5-10% higher than that of non-family firms. Kim and Lee [14] investigated whether the type of technological regime moderates the effects of entry timing, entry size, and active learning on firm survival. The study found that the effects of the factors influencing firm survival differed substantially across technological regimes. Using Kaplan-Meier estimator method and Cox proportional hazard regression model, Gemar et al. [15] analyzed the probability of survival of hotels in Spain. The findings indicate that the survival of hotels depends on their size, location, management and business cycle. And however, survival rates doesn’t depend on significantly the particular types of hotels or configurations of their economic and financial structures.

In light of the abovementioned previous studies, we engage in further discussion concerning the survival of the information service firms in Japan. For that purpose, this paper has no working hypotheses in advance, but makes exploratory approach and analyses empirically the factors influencing firm survival.

3. Data and method

In this section, the data and method of survival analysis are described. We use the non-parametric Kaplan-Meier estimator in order to detect the difference of life-span between Ind. group and Non-ind. group. Semi-parametric regression is applied with the Cox proportional hazard model, confirming which factors clearly influence the survival of the information service firms.

3.1 Outline of the Sample

We used a sample of 334 firms that belong to the information service industry which was extracted from the *Data Book* of Information Service Firms, edited by Ministry of Economy, Trade and Industry (METI) in Japan [16]-[20]. Publication of the *Data Book* was discontinued unfortunately, and 2000 edition is the latest available one.

Starting from 1997, we traced forward the sample for each four years: 2001; 2004; 2007; 2010 and calculated the amount of years that a firm in sample has stayed in business. If an existing (a registered) firm remained at a given year on the *Data Book*, it was considered as surviving until that year. While, if the firm disappeared from the *Data Book* due to either a closure or bankruptcy, it was regarded as an exit. However, even in that case, if the existence of the firm was confirmed by other media such as the Internet, we regarded it as still surviving.

For instance, if a firm is registered in the 2001’s *Data Book* and not listed in the 2004’s, it has been alive for 4 years from 1997 to 2001 and died even until 2004. However, because it cannot be said that it died just in 2004, the survival period is regarded as 6 years on average for simplification. Similarly, if a firm is registered in the both 2001’s and 2004’s *Data Book* but its survival is not able to be confirmed in the 2007’s, we regard the survival period of the firm as 9 years on average.

Figure 1 shows the definition of the observation period in this study. Both left truncation and right censoring is taken into account [21]. Right censoring occurs because the firms are still in operation at the end of the observation period. And left truncation is present because information on exit is only collected from 1997 onwards.

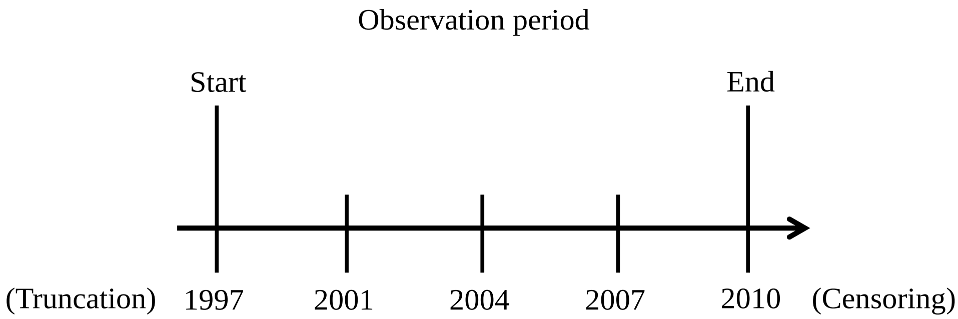

Fig. 1. Definition of the observation period

3.2 Kaplan-Meier estimator

The Kaplan-Meier estimator is a non-parametric method for estimating time-related events (Kaplan and Meier, 1958) [22]. It is known as a robust technique because it has few restrictions. That is, the only restriction to consider is that the observed firms - if the data are censored - are assumed to have continued behaving the same way as they did until the event (e.g. bankruptcy) occurred [15].

A variety of tests may be used to compare the survival functions among groups, but the log-rank test statistic is widely used in many studies in the management field. In the log-rank test, under the null hypothesis, the different groups have an equal chance of survival, so it has a chi-squared distribution.

The Kaplan-Meier estimator is useful for analyzing the duration or survival from the single point of view. However, to identify which factors influence the probability of survival, regression models are necessary which enable examining the multiple independent variables at the same time.

3.3 Cox proportional hazard regression model

Cox proportional hazard regression model is a semi-parametric method and the most general of the regression models because it is not based on any assumptions concerning the nature or shape of the survival distribution [23],[24]. Survival analysis typically examines the relationship of the survival distribution to covariates. Most commonly, this examination entails the specification of a linear-like model for the log hazard. The Cox proportional hazard model may be written as

$$h(t,x) = h_0(t)\exp(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k) \quad (1)$$

where x is the covariate vector, β is the unknown parameter vector estimated by using partial likelihood function and $h_0(t)$ is called the baseline hazard at time t. $h(t, x)$ denotes the resultant hazard, given the values of the covariates for the respective case and the respective survival time (t).

4. Analysis and results

We first briefly show the results of the log-rank test of survival functions between the group of independent firms (n = 152) and non-independent firms (n = 182). The result was significant (χ^2 (1) = 16.13, p = 0.00) and therefore the survival rates of two groups were not equal. In Figure 2, survival curves were depicted by Kaplan-Meier estimator method. We can find that the survival rate of the Ind. group is higher than that of the Non-ind. group. It is considered that the independent firms such as software vendors or houses face severe environment and suffer from the stress of market pressure, but these fact enables them to survive toughly. While, the non-independent firms such as subsidiaries are subject to the policy or control of their parent company, then disappearing from the *Data Book* does not always mean a bankruptcy.

Fig. 3 is shown for further discussion. These survival curves were drawn on the founded year basis. Because the *Data Book* also has information about the foundation year of each firm. It is the same for this result as mentioned above. That is to say, the result of the log-rank test was significant (χ^2(1) = 27.38, p = 0.00) and therefore the survival rates of two groups were not equal. The survival rate of the Ind. group is higher than that of the Non-Ind. group statistically in this attempt of analysis.

Next, we provide an overview of the regression analysis based on Cox proportional hazard model. The dependent variable is the hazard function which indicates the probability of event occurred in time (t). And eleven independent variables are used and examined which are each explained in detail below. Type of group (TYPE) is a dummy variable that takes the value 1 when a firm in sample is the non-independent firm and otherwise 0. Logarithmically transformed capital is used as a proxy for the firm size (SIZE). Then, a number of factors are relevant to the survival of firms, we address the two aspects: (1) economic structure and (2) technological capability in this study.

As a basis of economic structure, we prepare the three factors. Namely, sales per employee in log (SPE), sales profit ratio (SPFT), and sales ratio with main customers (SCUST). The rest of independent variables is related to the technological capability to perform by sales. These variables include system integration sales ratio (SI), software development sales ratio (SOFT), entrusted processing sales ratio (ENPRC), package software sales ratio (PACK), hardware sales ratio (HARD), and dispatching sales ratio (DISP).

System integration means the process or operation of creating a complex information system that may include designing or building a customized architecture or application, integrating it with new or existing hardware, packaged and custom software, networking, and storage products from multiple vendors. *Software development* is a business that is related to developing software for clients which works on a specific execution environment. *Entrusted processing* is a service providing entrusted with by customers about typical or routine data processing such as payroll calculation, ordering system and so on. *Package software*, also called *Packaged software* means a business to lay in stock of ready-made application software and sell it. Similarly, *Hardware* is about buying in stock of physical devices such as computer machine, storage, and so on from wholesalers, and selling them for wide end users. *Dispatching* is a service about temporary employee placement. It means a dispatch of a proper human resource according to the clients' requests.

The results of Cox proportional hazard regression analysis are shown in Table 1. The variable of TYPE was only introduced in Model 1. Variables considered in Model 2 were TYPE and groups of economic structure: SIZE, SPE, SPFT, SCUST. And we introduced all variables into Model 3 directly.

As shown in Model 1 through 3 of the Table, the coefficients of TYPE are positive and statistically significant. Also, the coefficients of SCUST are positive in Model 2 and 3. In contrast, the coefficients of SI, SOFT, and ENPRC are negative in Model 3. Therefore, the survival of the information service firms significantly depends on the degree of system integration sales ratio, software development sales ratio, and entrusted processing sales ratio. On the contrary, property of non-independent and high sales ratio with main customers have a negative effect on their own survivals.

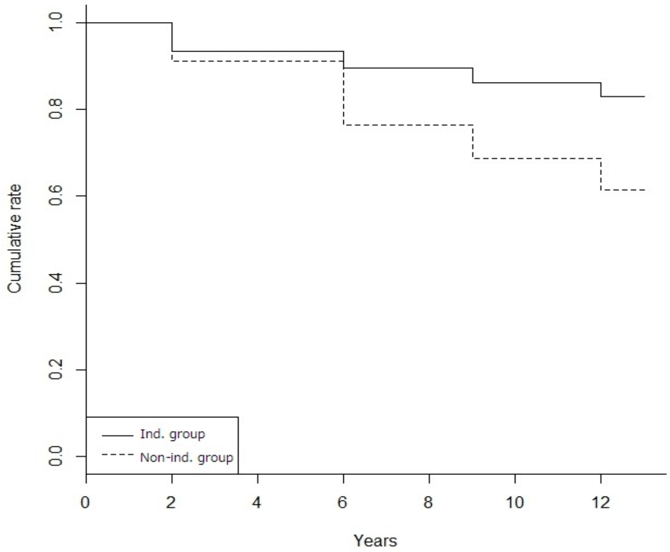

Fig. 2. Survival curves obtained from Kaplan-Meier estimator (starting from 1997)

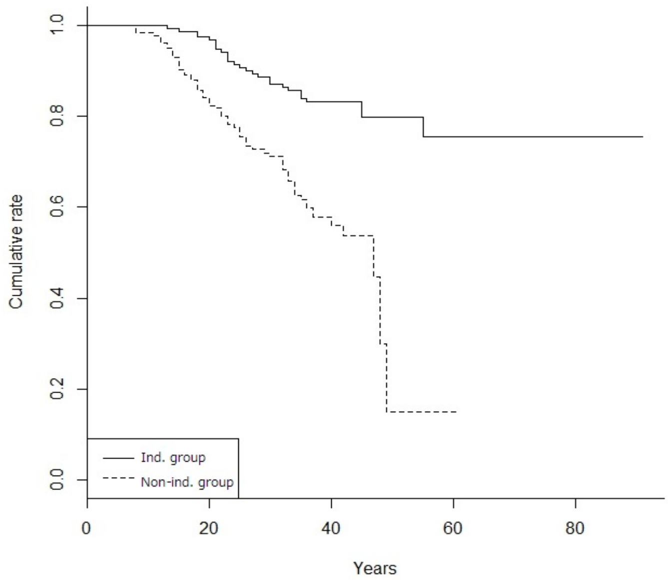

Fig. 3. Survival curves obtained from Kaplan-Meier estimator (starting from established year)

Table 1. Results of Cox proportional hazard regression analysis

Variable	Model 1	Model 2	Model 3
TYPE (0 = Ind.; 1 = Non-ind.)	0.894** (2.445)	0.600* (1.822)	0.662* (1.939)
SIZE	—	0.051 (1.052)	0.018 (1.018)
SPE	—	0.139 (1.149)	0.128 (1.136)
SPFT	—	0.025 (1.025)	0.015 (1.015)
SCUST	—	0.017** (1.017)	0.018** (1.018)
SI	—	—	-1.444* (0.236)
SOFT	—	—	-1.573* (0.207)
ENPRC	—	—	-2.823** (0.059)
PACK	—	—	-0.204 (0.816)
HARD	—	—	-1.385 (0.250)
DISP	—	—	-2.757 (0.063)
Sample size	334	330	330
Number of events	96	95	95
$\chi 2$	16.166**	34.265**	47.803**

**, * Statistically significant respectively at 1% and 5% level.

Hazard ratios are in parentheses.

5. Conclusion

This paper analyzed the lifespan of the Japanese information service industry by using Kaplan-Meier estimator and Cox proportional hazard regression model on a sample of 344 firms. As a result, survival of the information service firms significantly depends on the degree of system integration sales ratio, software development sales ratio, and entrusted processing sales ratio. On the contrary, property of non-independent and high sales ratio with main customer have a negative influence on their survival rates.

We acknowledge there are some limitations in this study. First, our framework, especially the definition of the observation period of the survival analysis is not strictly elaborate. This is because of simplification but it is a main limitation. Second, location property which is one of the most important factors of any firm's survival is not taken into account in this study. And finally, our survival analysis do not identify between bankruptcy and temporary exits for other reasons. Hence, future investigation, additional empirical analysis, is necessary. However, the results are potentially important because of providing useful information for practitioners. Many of founded significant factors depend on manager's choices, and, therefore, our results can help managers select optimal and/or successful strategies that increase their opportunities of survival.

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